Moelders, Florian

Conference Paper

Trade Persistence and the Limits of Trade Agreements

Proceedings of the German Development Economics Conference, Berlin 2011, No. 58

Provided in cooperation with:
Verein für Socialpolitik

Trade Persistence and the Limits of Trade Agreements

Florian Moelders*
DIW Berlin

This version: May 2011
(*Preliminary – Please do not cite without the permission of the author.*)

Abstract

International trade flows reveal strong persistence over time. This paper is concerned with the role of trade agreements in this persistent environment. The data reveal a high level of heterogeneity of the trade-creating effect along the trade volume and per-capita income distributions. If controlled for persistence in bilateral trade flows, I find that higher per-capita incomes are associated with smaller increases in bilateral trade flows if an agreement is present, compared to lower-income countries. This gives rise to a re-assessment of trade agreements and hence of economic policy. While they are a powerful tool for trading partners at the lower end of the per-capita income distribution, they are less so at the upper end.

JEL-Classification: F10, F13, F15
Keywords: Trade agreements, Gravity model, Trade persistence

1 Introduction

The literature on the empirical analysis of international trade flows has neglected potential heterogeneous effects of policy instruments. Traditional estimates of trade-creating initiatives have been evaluated using the gravity model that allows for the inclusion of standard variables such as the economic masses or the distance between the respective economies. Instead of concentrating on the effects of the treatment variable at the conditional mean of the sample distribution, this paper investigates the potential heterogeneity in the trade-creating effect of agreements. Furthermore, most analyses treat the gravity model as static without taking into account the dynamic dimension that might influence bilateral trade flows. But most countries' trading relationships have evolved over time and reveal a high level of persistence. The role that history plays in the establishment of bilateral trade relations has been stressed by Eichengreen & Irwin (1998) who e.g. refer to colonialization or past migration as possible drivers of unobserved trade shifters. Therefore, unobserved factors may well be responsible for a country pairs' tendency to trade with one another.

*Corresponding address: Mohrenstrasse 58, 10117 Berlin, Germany, ✉fmoelders@diw.de

The subject of this paper is to uncover a potential heterogeneous sensitivity of trading volumes and per-capita incomes with respect to trade agreements. I am especially interested in whether there is heterogeneity of the treatment variable for trading partners along the per-capita income distribution. I derive the motivation for the empirical analysis from the assumption that a strong persistence in trade flows among two economies may alter the responsiveness to policy instruments along the level of economic development, and be a driving factor behind the heterogeneity. The establishment of export networks (as an investment in the trading relationship and thus a sunk cost) may result in different cost advantages for RTA members that trade intensively (Arkolakis (2010)). The effects may further be differentiated along the per-capita income levels as it is questionable whether trade initiatives exhibit the same trade creating effect along all levels of economic development, and the associated trade basket (Schiff (1996)).

I make use of a rich panel dataset that allows for the elimination of unobserved time-invariant effects (Glick & Rose (2002)).[1] These effects may well refer to a country pair's tendency to trade more than others. Nevertheless, in a fixed-effects regression the corresponding coefficients of the time-variant variables only give information on the conditional mean of the trade volume distribution. What remains unobserved is the potential heterogeneity in the coefficients of the gravity variables of interest. Hence, I first analyze the standard gravity model with a quantile regression approach that allows us to take into account these heterogeneous effects. The behavior of the distribution with respect to the dummy variable reflecting trade agreements is of particular interest. The quantile regression is performed for illustrative reasons to uncover heterogeneity along the dependent variable with respect to the treatment variable, but this approach does not sufficiently take the dynamic structure of the gravity model into account. I then proceed with an analysis along the per-capita income levels. The results reveal significant differences for trading partners with low and high income levels. Larger elasticities are prominent at the lower end of the income distribution.

The results point towards an overestimation of the trade creating effect of trade agreements for trading partners that already trade at the upper quantile of the trade volume distribution and a more prominent trade-creating effect for country-pairs at the lower end of the level of economic development. Theoretical considerations pointing towards these results are outlined in chapter three. Following Arkolakis (2010) I build on a model with market penetration costs and model state dependence in bilateral trade flows that originate from investments in an export/distribution network at the firm level. I then confirm that, for exporters at the lower end of the productivity distribution (which is translated into lower per-capita income levels), the elasticity of exports with respect to a change in the variable trade costs is higher than for exporters at the upper end.

The rest of this paper is structured as follows: Chapter two gives an overview on the literature in this field of research and includes a summary on the current state of methods for using the gravity model. Chapter three develops a theoretical framework in which heterogeneity of trade creating effects of trade agreements may result. Chapter four introduces the econometric model and

[1] Furthermore, I use an own dataset as a robustness check. The data sources are somewhat similar but the dependent variable, the time-period and the number of the included regional trade initiatives differs. See section four for more information.

data in order to analyze the heterogeneity. Chapter five concludes.

2 Literature overview

Eichengreen & Irwin (1998) have stressed that bilateral trade evolves in a dynamic, rather than static, way. In this respect, the authors refer to regional trade agreements that reveal a higher than expected trade-creating effect. This persistence in trading relationships over time may be interpreted as the result of historical ties between any two economies. If not controlled for this factor, the respective coefficient of the RTA variable will overestimate the real effect of the agreement as it incorporates the trade persistence. Eichengreen & Irwin (1998) propose the inclusion of the lagged value of the dependent variable in order to control for the previous period's level of trade. This is a standard approach for tackling the dynamic relationship in the regression analysis. As expected, the resulting coefficient of the lagged value in the authors' estimation is highly significant and lowers the magnitude of other explanatory variables' coefficients considerably.

Harris et al. (2009) confirm the persistence in bilateral trade flows at the upper as well as the lower percentiles of the trade volume distribution. Bun & Klaassen (2002) base this persistence in bilateral trade flows on a fixed investment in distribution and service networks. Accordingly, these fixed costs lead trading partners to invest in a trading relationship and hence today's trade flows to be dependent on yesterday's. Based on the observation on persistence and the missing link towards the level of economic development, I put emphasis on the investigation of the treatment effect denoting RTAs along the trade volume and per-capita income distributions. This is motivated by a theoretical model that incorporates market penetration costs and allows trading partners to react differently to a change in variable trade costs.

H 1 *Bilateral trade flows at the upper and lower ends of the trade volume distribution are unevenly influenced by traditional gravity determinants, especially by trade agreements. Dynamics (state dependence) play(s) a larger role for country-pairs at the upper end.*

In order to investigate this hypothesis, I make use of a (pooled) quantile regression in section four, following Koenker & Bassett (1978). This allows for a more detailed analysis of a variable's effect and uncovers potential heterogeneity along the distribution. Contributions to the literature on the discussion of heterogeneous effects using the gravity model have mostly neglected the analysis of trade-creating effects of RTAs while simultaneously controlling for the dynamics in the panel data. This paper intends to fill this gap. Among those papers that do focus on heterogeneity are Milgram & Moro (2010) who investigate the different effects of gravity variables along the distribution of vertical intra-industry trade (IIT). The authors' emphasis lies on IIT and they take lagged trade volumes into account. Nevertheless, their dataset is restricted to Spanish trade data for the period of 1999-2000. Their inclusion of a dummy that denotes common membership in the European Union (EU) reflects a high level of heterogeneity, ranging from coefficient levels of around 1.25 (0.5) at the lower to around 0.25 at the upper percentiles. This suggests that the trade-creating effect is strongest for trading partners with lower trade volumes. Eaton

(2009) makes us of a larger dataset (T=17) and takes a closer look at the effects of intellectual property rights on seed trade.[2] The author bases his results on aggregate import data instead of bilateral country-pair data which limits the validity of the results since one has to rely on importer specific variables (such as membership of both countries in a trade agreement) in a fixed-effects quantile regression. The approach further limits the number of observations as bilateral trade flows are aggregated by year and importer. Nguyen & Arcand (2009) investigate the income and distance effects on homogeneous and heterogeneous goods using quantile regression. They use the single year 2000 for the regression analysis, which does not allow for either lagged trade flows or fixed effects. A study that comes close to the one presented here (in terms of heterogenous effects of trade initiatives) is Powers (2007). He focuses on the analysis of sectoral bilateral trade with respect to the trade-creating effects of trade agreements and investigates the data with a first-differenced specification following Baier & Bergstrand (2009). While the author controls for potential endogeneity using this technique,[3] the dynamic structure of the panel data is not controlled for with lagged trade values. Powers (2007) uses three years (1990, 1995 and 2000) in the regression analysis. While the application of the method by Baier and Bergstrand (2009) is reasonable, the arbitrary choice of the three years is not. Furthermore, the focus of his paper lies on the estimation of trade effects for sectoral trade flows, while mine is on the aggregate trade volume and uses a more extensive dataset (1948-1997), provided by Glick & Rose (2002), as well as self-compiled data (as a robustness check), based on similar data. In accordance to some of my findings, Powers' results suggests that RTAs have the strongest effects for those trading partners whose volume is at the upper end of the distribution. My results confirm this impression only if one incorporates the panel structure in the specification and splits the dataset into sub-samples.[4] Differences in the results may be caused by either the country coverage, which remains blurred in Powers (2007) (I do not know what countries are included in the dataset), the econometric approach or the country- and year-coverage.

Helpman et al. (2008) elegantly provide a gravity model framework that is based on the micro-evidence of the Melitz (2003) model but can be empirically implemented with country-level data. In one of their estimates, the authors divide their dataset according to the country-pairs that trade with one another over the period of 1970-1997. The sub-sampling of the dataset according to GDP per-capita levels allows a differentiation according to the trade-creating effects of trading partners at various levels of their respective economic development. According to their findings, the elasticity with respect to a change in bilateral distance is highest for trading partners that are referred to as "South-South", meaning that they are situated at the lower end of economic development. The authors base their result on the missing focus on the extensive margin of trade in previous estimates. Their result partly confirms the theoretical predictions outlined in this paper in section three as well as the empirical analysis in section

[2]Eaton does not find a significant effect of membership in an agreement on intellectual property rights on seed exports of the EU or US.

[3]Baier & Bergstrand (2009) make use of a Taylor-series expansion for a reduced form of the gravity model that includes multilateral price terms.

[4]This leads to a sample-selection bias as the samples are chosen on the basis of the dependent variable. I will elaborate further on this issue in chapter four. The respective results are not reported but are available upon request from the author.

four. One of the differences in the approach by Helpman et al. (2008) from the one presented here, is my focus on trade persistence and hence on dynamics in the regression analysis. The qualitative conclusions with respect to heterogeneous responses are nevertheless similar and can be confirmed, yet motivated from a different angle and empirically implemented along sub-samples that are of almost equal size.

Another strand of the literature on potential heterogeneity of the effect of a trade-enhancing treatment for country-pairs derived from the discussion about the effectiveness of membership in the WTO. Starting with the seminal paper by Rose (2004), there has been a vivid discussion on whether membership in the WTO is beneficial in terms of its trade-creating effects. While Rose neglects heterogeneous effects of GATT/WTO membership on the trade volume, Subramanian & Wei (2007) differentiate between the effect on developing and industrialized countries' trade. While they find only little influence of membership on the imports of developing countries, developed economies reveal a substantial increase in imports. Similar results are found in Chang & Lee (forthcoming) who use matching to derive the heterogeneity in the GATT/WTO trade effect. Both studies have in common that their results point towards a strong trade effect for industrialized (developed) economies while the respective effect for low-income (developing) countries is significantly lower, if existent. Eicher & Henn (2011) go one step further and take a look at potential heterogeneous effects of preferential trade agreements (PTAs). Their results on the effect of WTO membership have the potential to revitalize the afore-mentioned discussion,[5] and their findings on PTAs suggest that there is substantial heterogeneity in the effect of membership in a trade initiative: developing economies benefit with a trade increase of 214 percent while the industrialized economies' equivalent points towards a 16 percent increase (without controlling for fixed effects). While the research question of Eicher & Henn (2011) is quite similar to the one presented here, the theoretical motivation and the empirical analysis differ considerably. As I outline in the next two sections, I put emphasis on the time-dimension of bilateral trade in terms of dynamics. Further, Eicher & Henn (2011) identify the trade effect of PTAs by splitting the respective agreements according to the countries included in them (developing or developed). In contrast, I split the dataset into subsets to objectively control for per-capita income differences, and check the results for robustness using my own dataset.

I make a case for a theoretical motivation of the empirical results by assuming distribution or marketing networks, as proposed by Arkolakis (2010). This model provides an excellent framework which allows for a proper description of the data and the empirical results, even though I do not analyze firm-level but rely on country-level data. The results may also be interpreted against the background of the sectoral composition of trade: In sectors that are dominated by trade in homogeneous goods, the average productivity level is lower than in sectors that exhibit a high level of heterogeneity (see Melitz (2003)). Furthermore,

[5]The authors do not find any trade effect coming from the WTO once they control for multilateral resistance, unobserved bilateral heterogeneity and PTAs: "It may well be the case that developing countries reoriented their import activity considerably towards PTA partners after joining PTAs. This reorientation might produce trade creation, but it might also include some trade diversion that redirected trade from WTO trade partners to fellow PTA members. If this is a common pattern among developing countries, such a reorientation would have a negative impact on the WTO estimate for developing countries [...]."

the level of economic development (in terms of per-capita GDP) has proven to be positively dependent on the average productivity level of a country's export basket (Rodrik (2006)).[6] The sensitivity with respect to changes in variable trade costs has more weight in these sectors, as the move in the productivity threshold then leads more firms to exit and enter (Chaney (2008)). Rodrik (2006) further points out that the "productivity level of the export basket" of a country is strongly correlated with the per-capita income. The theoretical considerations lead to a second hypothesis on heterogeneous trade effect responses:

H 2 *Trade agreements have a stronger trade-creating effect for country-pairs at the lower end of economic development (in terms of per-capita GDP).*

The recent literature on international trade has highlighted the importance of productivity differences. I argue that these differences may well be the driving force behind my results through the channel of endogenous distribution networks (following Arkolakis (2010)). Therefore, the contribution of the empirical analysis rests on emphasizing the heterogeneity in the effects of economic policy variables on trading partners while the following section simultaneously makes a case for a sound theoretical motivation and stresses the importance of dynamics in the gravity model of international trade.[7]

3 Theoretical motivation

3.1 What model?

I analyze the relevance of regional trade agreements for bilateral trade flows along the trade volume distribution and investigate a potentially heterogeneous influence across the per-capita income levels. One reference for the economic reasoning behind this lies in the dynamics of international trade and has been marked by Eichengreen & Irwin (1998) who state that sunk costs relate to the persistence in trade flows. These costs may incur due to distribution and sales networks that have to be established in order to sell into a foreign country.

In the more recent literature, fixed costs take a prominent role in the determination of the number of trading partners (extensive margin), the volume of exports (intensive margin) and the number of goods that are exported. Starting with the model of firm heterogeneity by Melitz (2003), productivity differences of producers became increasingly incorporated in subsequent trade analyses. Accordingly, productivities lower the per unit production costs and allow more productive firms to sell into markets that require a higher fixed cost amount to enter. Sunk costs are determined by trade barriers and other bilateral resistances. Network structures that need to be set up in order to export point towards the same argument. Following the results of Chaney (2008), a decrease in trade barriers will alter both the intensive and extensive margins of trade. The former will increase as existing exporters are faced with lower trading costs.

[6] Yi (2003) shows that vertically specialized trade is more sensitive to changes in variable trade costs. One should consider that vertical specialization is prominent for developing or emerging economies.

[7] On a related note, Dufrenot et al. (2010) e.g. analyze the effect of trade openness on the growth of per capita income with quantile regression. Their finding suggests that trade openness has a stronger effect on trading partners at the lower end of the distribution, and a weakening one towards the upper quantiles.

At the same time, more firms enter the foreign market which have previously been excluded from entering due to the higher trade barrier. Chaney's results are linked to the products' elasticities of substitution (σ): depending on the magnitude of the elasticity, the sensitivity of the intensive and extensive margins differs. If σ is high (the market share of each firm is relatively small), firms with low levels of productivity will only be able to acquire small market shares. This results in small changes in overall exports to the respective market due to the new entrants. The effect of trade liberalization, according to Chaney (2008), is dampened by the elasticity of substitution. On the aggregate level, one has to distinguish between producers of homogeneous and heterogeneous goods. The former are relatively more present in sectors with lower levels of productivity, whereas the latter reveal higher productivity levels on average. As the productivity threshold (the level under which no firm finds it profitable to export) moves due to a change in the variable trade costs (e.g. transport costs or lower tariffs), aggregate exports become more sensitive in homogeneous sectors. The elasticity of trade with respect to variables denoting trade costs (distance, trade agreements) will then be comparably lower in heterogeneous sectors. This gives rise to a careful treatment and interpretation of the elasticities denoting variable trade costs, especially with reference to the level of economic development. The associated per-capita income level is highly interconnected with the average productivity level of a country's export basket (Rodrik (2006)). I therefore focus on the effect of trade liberalization along the per-capita income level in section four.

Combes et al. (2005) investigate the role of business and social networks in trade between French regions. They rely on data of migrants and French firms. Migrants are likely to make use of their existing network at their origin and source goods from these regions. Firms may establish networks in a foreign region via foreign direct investments (FDI) that connect regions in a vertical production network. Further, firms may decrease their information costs with networks or increase their reputation that allows them to persistently access a stable consumer base. In a dynamic gravity analysis, Campbell (2010) refers to the creation of distribution chains and sales networks that facilitate exports but incur sunk costs. The author stresses the persistence in international trade flows (he goes back to the 1870s) as a determinant of today's flows.

Also based on the firm level, Arkolakis (2010)' model predicts larger elasticities with respect to a change in trade costs for firms at the lower end of the productivity distribution.[8] The opposite effect is prevalent for large exporters and their respective effect of a decrease in trade barriers. The author's conclusions are drawn from the effects of an extension of a firm's consumer base on sales in the market. Accordingly, a change in trade costs (e.g. the establishment of a trade agreement) can have larger effects on small exporters. In the following, I will further elaborate on the model by Arkolakis (2010) as it provides a sound theoretical background for what I think may drive the heterogeneity in country-pairs' responses to trade agreements. In chapter four, I adjust the model to be able to incorporate a dynamic structure in the regression analysis.

[8] His model incorporates marketing costs that incur to reach the consumer in the exporting market.

3.2 A model with endogenous market penetration costs

International trade flows should be modeled with dynamics rather than static. This conclusion can be drawn e.g. from Eichengreen & Irwin (1998). Underlying network structures and productivity differences can lead today's trade flows to be dependent on the past. I incorporate these differences into a theoretical framework that reflects trade persistence with guidance from the model provided by Arkolakis (2010). His model assumes away the fixed market-entry costs that are prevalent e.g. in Melitz (2003), but introduces endogenous market entry or penetration costs that reflect the ability of a firm to reach a certain consumer base. In my representation of the model, it is essential that the marginal costs of reaching a new consumer in a foreign country are dependent on the existent consumer base of the firm in the foregoing period. The firm experiences diminishing returns to scale with respect to the investment in market penetration. This assumption leads us to a dynamic model that has the potential to explain heterogeneous responses to a change in variable trade costs for low and high productivity firms. Even though I rely on most of the assumptions made by Arkolakis (2010), the model is simplified such that I capture the main features needed for transformation to the empirical part and add a dynamic structure. Further, Arkolakis refers to marketing costs whereas this is merely a metaphor for anything that needs to be invested in a foreign country before a firm can sell its product. I therefore refer to these costs as investments in the export/distribution network in the foreign country.

The "network"

The number of potential consumers in country j is denoted by L_j.[9] In order to reach consumers, the firm invests in a network of size S. The probability of reaching a certain consumer after the firm has invested in the size S of the network is $n(S)$. The key ingredient of the theory lies in the diminishing returns: doubling the size of the network (and hence the investment) does not lead to an equivalent growth of the consumer base. This feature is captured by the probability that a consumer is reached by the network for the first time:

$$(1 - n(S))^{\beta}, \tag{1}$$

with β in $[0, +\infty)$. Reaching consumer number one for the first time in a city by setting up a distribution network is easier than reaching consumer 1,000 without simultaneously reaching consumer one again. This diminishing effect of investment in the distribution network is reflected by β and is central to the hypothesis on heterogeneous responses to a change in variable trade costs. The higher the β, the higher the diminishing returns to scale of a euro spent on the network.

The consumer

Each consumer in the economy maximizes utility according to standard Dixit-Stiglitz preferences, common in a monopolistic competition setting. Utility is derived from consumption of a bundle of goods, each denoted by c_{ijt}

[9] Arkolakis (2010) denotes the number of consumers that are aware of an ad of a certain firm by $L_j^{1-\alpha}$ which allows the type of marketing to differ in its outreach. I set α equal to unity.

for the consumption of a good from country i in country j at time period t. Accordingly, we can write

$$U_{jt} = \left(\int_0^N c_{ijt}(\phi)^\rho d\phi \right)^{\frac{1}{\rho}}, 0 < \rho < 1, \tag{2}$$

where N denotes the number of varieties that are available to the consumer, $c(\phi)$ the quantity consumed from each of the varieties and ρ refers to the substitutability of the varieties and translates into the elasticity of substitution $\sigma = \frac{1}{1-\rho}$. As I consider the exports of firms and as these firms are heterogeneous with respect to their productivity levels, we can identify a variety at the firm level of productivity (ϕ) because each variety is produced by a single firm only. Solving the maximization problem of the consumer with respect to her available income y_{jt}[10] yields the demand for a variety,

$$c_{ijt}(\phi) = \frac{p_{ijt}(\phi)^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt}. \tag{3}$$

Combined with the total number of consumers reached with the distribution network, the total demand of a firm with productivity ϕ from country i in country j at time t amounts to:

$$q_{ijt}(\phi) = \underbrace{n_{ijt}(\phi) L_{jt}}_{\text{Number of consumers reached}} \times \underbrace{\frac{p_{ijt}(\phi)^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt}}_{\text{Demand per consumer}}. \tag{4}$$

The firm

In accordance with the literature on firm heterogeneity, firms draw their productivities (ϕ) out of a Pareto distribution such that the firm problem reduces to a maximization problem with respect to the size of the network and the price of the product. We can combine the previous equations into a profit function that consists of three segments:

$$\begin{aligned} \pi_{ijt}(p, n, \phi) = & \underbrace{n_{ijt} L_{jt} y_{jt} \frac{p_{ijt}^{1-\sigma}}{P_{jt}^{1-\sigma}}}_{\text{revenue from sales}} - \underbrace{n_{ijt} L_{jt} y_{jt} \frac{p_{ijt}^{-\sigma} \tau_{ijt} \omega_{it}}{P_{jt}^{1-\sigma} \phi}}_{\text{production costs}} \\ & - \underbrace{\omega_{jt} \frac{L_{jt}}{\psi} \frac{1 - (1 - (n_{jt} - \varphi n_{jt-1}))^{1-\beta}}{1-\beta}}_{\text{network costs}}. \end{aligned} \tag{5}$$

The last term refers to the costs that originate from the distribution network in country j.[11] This representation additionally includes the lagged value of the

[10] Composed of labor income ω_{jt} and firm profits π_{jt}.

[11] I refer to Arkolakis (2010), page 1157 for the derivation of equation (5). The author uses $\frac{1}{\psi}$ to denote the labor requirement for an additional ad in the marketing of the products.

network size (φn_{jt-1}) that is needed to incorporate dynamics in the regression analysis. The size of the network in period $t-1$ is subject to deterioration of size $1-\varphi$. This assumption guarantees that each firm has to consider reinvestment in the network of a certain amount each period t. Costs that represent maintenance of distribution chains or a reorientation of the marketing towards new customers are intuitive examples that justify φ to be smaller than unity.

Optimization of equation (5) with respect to the size of the network in period t, dependent on its size in the foregoing period $t-1$, results in the following optimal size, dependent on the size in the foregoing period:[12]

$$n_{ijt}(\phi) = 1 - \varphi n_{ijt-1}(\phi) - \left[\frac{y_{jt}\phi^{\sigma-1}(\tilde{\sigma}\tau_{ijt}\omega_{it})^{1-\sigma}\psi P_{jt}^{\sigma-1}}{\omega_{jt}\sigma}\right]^{-1/\beta}. \qquad (6)$$

This solution to the optimization problem is a modified version of the one to be found in Arkolakis (2009), with $\tilde{\sigma} = (\sigma)/(1-\sigma)$. The labor required for the penetration of the foreign market is restricted to be of foreign nature, and not a mixture of both foreign and domestic. Instead of introducing the possibility to mix foreign with domestic labor for the setup of the network (which would be in accordance with Arkolakis), I refrain from this assumption as the complexity involved in the model exceeds the respective representation in the empirical part of this paper.[13] The term τ_{ijt} denotes the variable trade costs that will be central to my empirical analysis in section four.

Trade agreements lower trade barriers such as tariffs and thus lead to lower per-unit costs of exporting. Now, what happens when trade barriers are removed? I translate this removal into a decrease in variable trade costs via a lower tariff barriers. Following Arkolakis (2010), a decrease in trade costs lowers the threshold productivity below which no firm finds it profitable to export to the foreign country. Firms that did not find it profitable to export before now export, increasing the extensive margin of exporters. At the same time, firms that have exported small amounts before can now export more due to lower trade costs. This intensive margin is more prominent for firms at the lower end of the productivity distribution as an investment in the exporting network attracts more new consumers, compared to an investment for firms at the upper end. This is due to the diminishing returns to scale described above. Therefore, we can assume that the elasticity of exports with respect to a change in the entry threshold is higher, the lower the respective firm's productivity.

Dynamics

Equation (7) reflects a dynamic relationship in the profit function of the firm which is governed by the choice of investing in the distribution network in time t, subject to the existing network size in $t-1$: φn_{ijt-1}.[14] The dynamic relationship is best represented by a Markov process that allows the relevant

[12] Note that the optimal pricing of the firm yields: $p_{ijt}(\phi) = \tilde{\sigma}\frac{\tau_{ijt}\omega_{it}}{\phi}$

[13] Additionally, I assume constant returns to scale with respect to the population size L_j. In contrast, Arkolakis (2010) introduces a parameter that can adjust marketing efforts to exhibit increasing returns to scale when it comes to the size of the population.

[14] Up to this point, my focus lies on the state dependence of the size of the network. I exclude any detailed analysis of the growth rates of productivity levels or any other state variables.

information on a state variable to be included in the foregoing period. The Markov property writes as follows:

$$P(n_{ijt} = z | n_{ij1} = z_1, ..., n_{ijt-1} = z_{t-1}) = P(n_{ijt} = z | n_{ijt-1} = z_{t-1}). \quad (7)$$

In the case presented here, a Markov representation has two advantages: first, I can model the decision of the firm to be dependent on the state variable in $t-1$ and thus circumvent any treatment of periods bygone more than one period. Second, Brownian motion process are Markov processes that can be used for the representation of the evolution of the productivity levels (following Arkolakis (2009)), given an initial size. The random component in the Markov process is the draw from the probability distribution of the productivities (ϕ) whose *pdf* is given by $g_{it}(\phi) = \theta b_{it}^{\theta}/\phi^{\theta+1}$. Arkolakis (2009) uses the Brownian motion assumption to model the "relative size of an idea" (which translates into productivities above some threshold level). I can translate this idea to my framework by making additional assumptions on the by-period rate of decay of the existing network $(1-\varphi)$ and the initial size of it (n_{ij0}). The random part of the Markov process is determined by parameters that belong to the random variable ϕ. Hence, the optimal size of the network is described by equation (6) whose only random component is the productivity level of the firm in period t. We can therefore convert the size of the distribution network of firm i in country j in period t to be dependent on the distribution parameters of the productivity distribution.

The aggregation of the firm-level perspective to the country-level is a matter of country-specific productivities. The productivity *pdf* drives the number of firms in country i that are active in exporting to country j. Given this information on the number of firms, the population of exporting destination j and the respective per-capita income level y_{jt}, total exports can be displayed in a gravity fashion:

$$T_{ijt} = \lambda_{ijt} L_j y_j, \quad (8)$$

where T_{ijt} denotes total trade in period t from i to j and λ_{ijt} carries information on the productivity parameters prevalent in country i such that we are able to assess the number and type of firms that export. Information on the bilateral trade barriers such as distance and tariffs are also included in this term. The remaining part of (8) refers, in a gravity fashion, to the economic mass of country j. Note that the size of the exporting network (market penetration) enters the equation via λ_{ijt} but, as was mentioned above, the size of network is a function of the productivity levels.

If I assume the existence of unobservable, time-variant factors driving the persistence in bilateral trade volumes, I may well denote this factor (the network effect) by N_{ijt} and include it in my outcome equation (the gravity model). In order to incorporate the dynamics in the panel data and as I assume that the network effect represents the persistence in bilateral trade, T_{ijt} is likely to positively depend on the size of the network in period $t-1$:

$$T_{ijt} = f(N_{ijt-1}), \quad (9)$$

where N_{ijt-1} denotes the network size of the foregoing period. If I want to control for the unobserved and time-variant effect of "network effects", the most applicable way would then be to make use of the lagged dependent variable as an instrument. T_{ijt-1} would then be highly correlated with the unobserved N_{ijt-1}[15] but by construction not with the current trade flow T_{ijt}. This follows from the assumption that todays' bilateral trade is altered by trade in period $t-1$ by nothing else but N_{ijt-1}.[16] This argumentation leads to a dynamic panel data analysis of the gravity model. I show that the significant heterogeneity of the coefficient, of e.g. the RTA variable, is weakened towards the upper percentiles in a quantile regression without panel structure. This would suggest, that once there is a strong trading relation between two economies, a change in one of these determinants leads to a smaller change in the trade volume than for low-trading partners.[17] A marginal change in the variables determining the trade liberalization now adds relatively little to the overall barriers between the two economies. To put it another way: intense trade between two countries has already overcome substantial trade barriers until period t and further removal of a barrier in $t + 1$ now leads to a relative change in the trade volume that is proportionally factored according to the consumer base or export network.

Details on the econometric specification will be outlined in the next section, where I analyze whether the economic reasoning suggested above is mirrored by the empirics. To incorporate the afore mentioned dynamics, the model has to be adjusted accordingly. I accommodate the model by including lagged trade volumes as these may alter the effect of other explanatory variables (such as trade agreements).

4 Econometric Method and Data

In this section, I first outline the econometric approach and then describe the dataset that is used. As mentioned before, I try to enlighten the dynamics in international trade flows by focusing on the heterogeneity in gravity estimates. To do so, I need a tool that reflects this approach. Quantile regression has the advantage of pointing towards heterogeneous effects along the distribution of the dependent variable.[18] In this respect, I follow Koenker & Hallock (2001). Instead of solving for the conditional expectation function (as would be the case in a standard OLS estimation), the minimization problem of the conditional quantile function is solved according to the following function and yields the coefficients for the respective quantiles τ:

$$\beta_\tau = arg_{(b)} min \sum \rho_\tau (Y_i - X_i(b)). \tag{10}$$

[15]Note that this correlation is expected to be higher for trading partners at the upper levels of the trading volume distribution.

[16]Nevertheless, the unobserved and time-invariant part of the error term is common to both T_{ijt} and T_{ijt-1} which leads the lagged variable to be correlated with the error term, causing the dynamic panel bias (Nickell (1981)). In the empirical part of this paper, I will further approach this issue.

[17]In this respect, countries that trade in high volumes may be subject to the "natural trading partners" hypothesis by Wonnacott & Lutz (1989).

[18]See Angrist & Pischke (2008) for a comprehensive summary of quantile regression.

Where β solves for the minimum value of the quantiles. ρ_τ denotes the "check"- function that represents an asymmetric loss function and (compared to the loss in squared errors for the minimization of least squares) gives smaller weight to outliers.[19]

Quantile regression can be used for various specifications of the regression equation as long as the dependent variable is continuous. In my case, the specification is described by the gravity equation of international trade flows. The dependent variable denotes the bilateral trade flow between countries i and j in period t. The evolution of the effect of the treatment variable (RTA) for the upper and lower quantiles is of special interest. In a further step, I analyze the behavior of this treatment variable with respect to per-capita income levels of the trading-partners. I want to investigate whether trade-creating effects of trade initiatives reveal any heterogeneity across the level of economic development, as was outlined in the previous section. I do so by making use of a dynamic panel analysis that, compared to the quantile regressions, does not rely on a pooled approach. Other, more recent, contributions that stress the importance of incorporating dynamics in the gravity equation, are Bun & Klaassen (2002) and Harris et al. (2009).[20] The former refer to distribution and service networks that cause fixed costs during the trading relation's establishment. These entry barriers may lead to a persistence of trade flows in the short and flexibility only in the long run. Benedictis & Vicarelli (2005) follow the same reasoning and explicitly refer to the European context where the stickiness of trade flows is related to the accumulation of invisible assets that are of political, cultural and geographical nature.[21]

The gravity model

The empirical literature on international trade flows is dominated by its workhorse: the gravity model. First introduced by Tinbergen (1962), the gravity model was rapidly recognized as an excellent tool for the analysis of bilateral trade flows. Even though the model reflected an excellent fit to the data, a theoretical underpinning was needed. The contributions of Anderson (1979), Bergstrand (1985) and Anderson & Wincoop (2003) have added substantially to the economic foundations of the model. Its high explanatory power and sound theoretical underpinnings make it a useful tool for uncovering bilateral trade flows' determinants. While the basic economic relationships are easily described by the model (positive influence of countries' GDPs and a negative influence of bilateral distance), the challenge over the past decade was to establish an econometric approach that would match the increasing use of panel data. The combination of time-series and cross-sectional data allows the researcher to draw considerably more information out of the data than is the case in cross-sectional estimates. Prominent examples that stress the use of the associated fixed- and random-effects models are Baier & Bergstrand (2002), Baier & Bergstrand (2007) and Magee (2008).[22] The use of fixed-effects elimi-

[19]The function is defined as $\rho_\tau(u) = \tau * |u|$ if $u > 0$ and $\rho_\tau u = (1-\tau) * |u|$ if $u \leq 0$.

[20]Bun & Klaassen (2002) stress the use of the Arellano-Bond estimator which makes use of lagged dependent variables as instruments to control for the dynamic panel bias.

[21]This claim is also made by Nardis & Vicarelli (2003).

[22]Magee makes use of a Poisson estimator in a gravity model. This method (first introduced by Santos Silva & Tenreyro (2006)) has two advantages: First, it allows to include zero-trade values and hence observations that have previously either been dropped from the data or

nates all unobserved, time-invariant effects that may alter a country-pairs' bilateral trade. This potential source of endogeneity has been stressed by Baier & Bergstrand (2007) who advocate the fixed-effects model when estimating the effects of trade agreements. One considerable disadvantage of this approach is that only time-invariant factors are controlled for. Unobserved time-variant factors that simultaneously affect bilateral trade as well as the establishment of trade agreements will remain in the error term and may cause an endogeneity bias.

The equation that I estimate as benchmark equation takes the following form:

$$\begin{aligned} X_{ijt} = \beta_0 + \beta_1 ln(D_{ij}) + \beta_2 Border_{ij} + \beta_3 Language_{ij} \\ + \beta_4 ln(GDPAB_{ijt}) + \beta_5 RTA_{ijt} + v_{ijt}, \end{aligned} \tag{11}$$

where X denotes the average trade flow between countries i to j in period t. The explanatory variables on the right hand side are fairly standard in a gravity setting.[23] My focus lies on the behavior of the coefficient β_5, because it denotes the increase in trade flows due to the existence of a trade agreement between the trading partners, as well as the respective significance level.[24] I also focus on the behavior of the error term v_{ijt}. As I work in a panel environment, the error term might consist of more than just the idiosyncratic part. v_{ijt} may well carry country-pair specific information that may influence both the dependent as well as some of the independent variables. This sort of endogeneity can be controlled for using fixed effects that eliminate any time-invariant effect in the regression equation.[25]

I will perform baseline regressions with the data in the next chapter to benchmark my results. A variety of econometric specifications are available, when analyzing the gravity model. The panel structure of the data demands for a proper treatment of the idiosyncratic and time-invariant, country-pair specific part via fixed effects estimation if a specification test (Hausman test) rejects the random effects model. Furthermore, I can estimate the model using GLS or, as proposed by Santos Silva & Tenreyro (2006), employ Poisson regressions. The advantage here lies in the treatment of the error term that might exhibit heteroskedasticity. In this case, Poisson will be favored as it does not rely on the homoskedasticity assumption of the error term and thus is more robust in the presence of a heteroskedasticity.[26] Even if the proportionality condition ($E(Y|X) \propto Var(Y|X)$) does not hold strictly, Poisson is more adequate than models that rely on homoskedasticity assumption (OLS).

In order to control for potential dynamics in the gravity model,[27] I incorporate the lagged value of the dependent variable in the regression equation. Here, I follow the theoretical motivation of chapter three that demanded for a

transformed. Second, Poisson is more robust in the case of heteroskedastic error terms.

[23] D_{ij} denotes bilateral distance, $Border_{ij}$ and $Language_{ij}$ indicate whether the country-pair shares a common border and language, and $GDPAB_{ijt}$ refers to the product of the country-pair's GDPs. v_{ijt} denotes the error term that includes both the time-invariant and the idiosyncratic part.

[24] I expect the trade agreements to have a non-negative effect on export volumes.

[25] See Baltagi (2005) for a comprehensive contribution on handling panel data with fixed effects and other attributes.

[26] See Winkelmann (2008) for further justification of the Poisson model in non-count models.

[27] As can be tested via an Arellano-Bond test.

dynamic adjustment in order to incorporate the persistence in bilateral trade flows. After this small modification, the estimated equation looks as follows:

$$X_{ijt} = \beta_0 + \beta_1 lnX_{ijt-1} + I_{ijt}. \tag{12}$$

Where I denote I_{ijt} to be the remaining variables on the right hand side of (**X**).

The econometric specification used to incorporate the dynamics demands a cautious treatment of the panel structure as ordinary quantile regression does not allow for a treatment with fixed effects, like GLS does. Instead, I have to rely on pooled quantile regression estimates. The theoretical motivation in chapter three and the explanations given in this chapter stress the importance of including dynamics and to make use of fixed effects. Additionally, the focus of this paper lies in the analysis of heterogeneous trade effects along the level of economic development. I therefore also perform another specification that allows for the inclusion of panel fixed and dynamic effects. I separate the dataset into four quantiles according to the distribution of the per-capita income variables (as can be seen in figure 1). This method allows us to select the sample conditional on per-capita income quartiles and estimate the respective gravity coefficients that display the effect of a trade agreement. The data have been classified into quartiles such that the evolution over time (countries become richer) does not bias the classification. Country-pairs that have e.g. been in the first quartile with their per-capita income of the first year of the time-span may well end up in the fourth in the latter years. I have sub-sampled my data such that country-pairs are ordered in quartiles according to their ranking in any respective year.

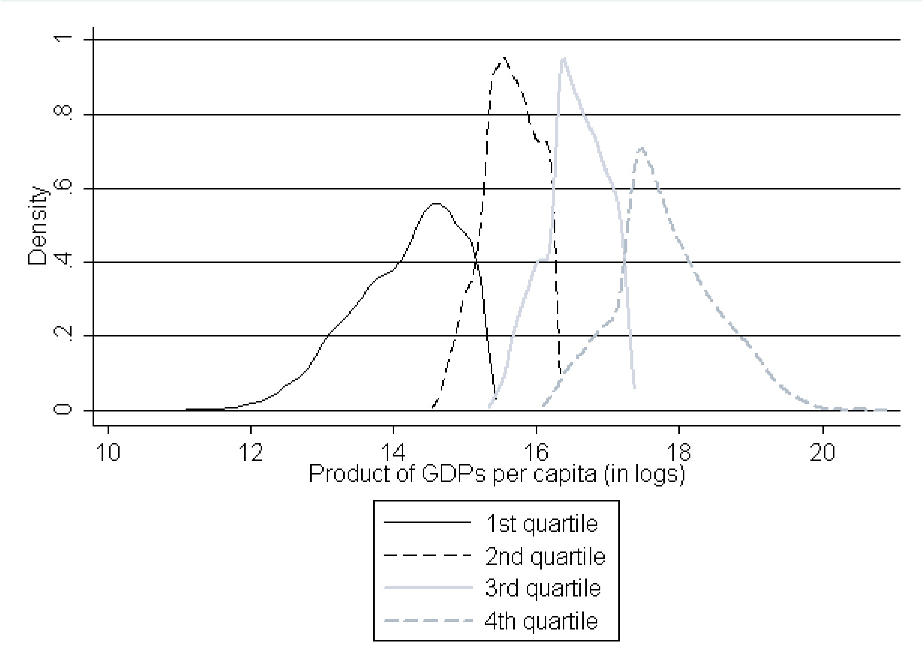
A sub-sampling approach for the trade volume distribution does not qualify for a proper comparison with the quantile regression estimates, as outlined by Koenker & Hallock (2001). The fallacy lies in the classical sample-selection bias that occurs by segmenting the dataset according to the dependent variable. In the subsequent analysis, I focus on a sub-sampling according to the per-capita income. I hereby reveal some interesting findings pointing towards the heterogeneity in the effects of RTAs and circumvent the (endogenous) sample-selection problem at the same time.[28]

Data

I make use of aggregate trade data as the research question points towards an assessment of trade liberalization measures that are not aimed at any particular sector. I further analyze panel data that convey information of both the cross-sectional and time-series type to include the time-dynamics in bilateral trade. For comparative reasons, the data are taken from Glick & Rose (2002) and their period of observation ranges from 1948-1997 and covers 217 countries. This long period has at least two advantages: first, I can draw information from a large within variation and second, the dynamic panel bias decreases with an increasing number of years/periods (Alvarez & Arellano (2003)). This will be of particular interest when it comes to the evaluation of the estimates in the following chapter. I run robustness checks with another, self-compiled dataset

[28]See Wooldridge (2009) for a note on (exogenous) sample selection. Thereafter, sample selection does not lead to a bias if the selection is based on explanatory variables.

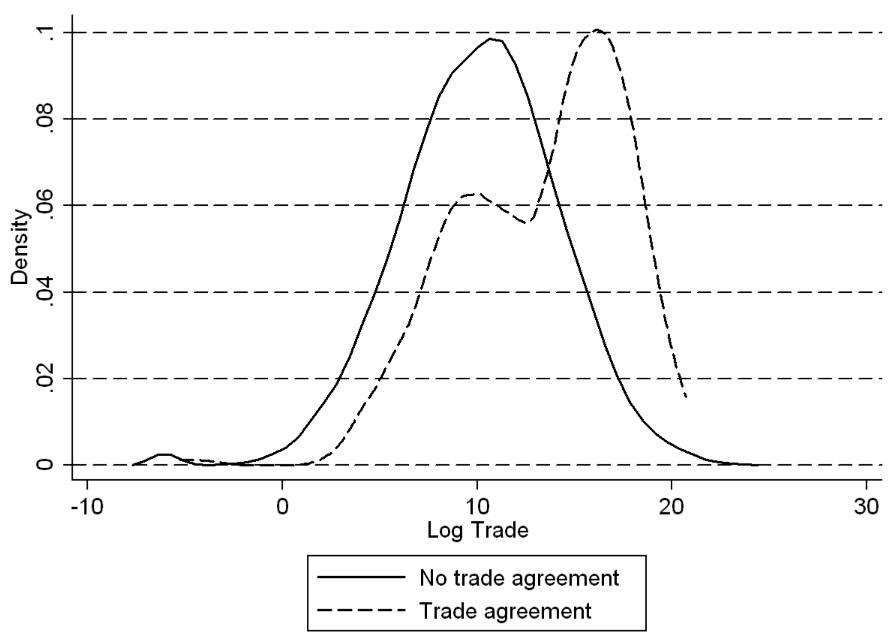
Figure 1: Per-capita income quartiles, Glick and Rose data



in order to compare the results of the publicly available data of Glick & Rose (2002). In both cases, the trade data is sourced from IMF's *Direction of Trade Statistics.* Glick and Rose rely on the average of bilateral exports and imports as the trade flow, whereas my data focuses on exports. The dependent variable is denominated in constant US Dollars in the Glick and Rose dataset compared to current US Dollars in my data. In both datasets, the values for the respective economies' GDPs are in constant US Dollars, drawn from three different sources in the Glick and Rose dataset (World Bank's *World Development Indicators*, *Penn World Tables* or from IMF's *International Financial Statistics*) and *Penn World Tables* in the alternate dataset. The variables that describe the geographic characteristics (distance, border and language) are sourced from the *CIA World Factbook* for the data by Glick and Rose. CEPII data on geographic characteristics were the source for the self-compiled data. Taking into account the unbalanced panel structure of both datasets, this gives a total of 219,558 (Glick and Rose) and 263,408 (own data) observations that can be used for the estimations. The higher number of observations in the second case results from a longer time span (1950-2006). I make use of information on regional trade agreements from Head et al. (2010) who source their information mainly from WTO data, whereas Glick & Rose (2002) only include the following agreements: EU, US-Israel FTA, NAFTA, CARICOM, PATCRA, ANZCERTA, and Mercosur. In the following, I will display descriptive statistics based on the data from Glick & Rose (2002) for comparative reasons. Only for the regression analysis, I will refer to the alternative dataset.

A glance at the data suggests some interesting, yet obvious, findings: First, the kernel densities of bilateral trade have been separated into two groups. The observations for which the country-pairs have a common trade agreement in place, and those that do not. Both densities are plotted in figure 2, exemplarily for the year 1997.[29] It is obvious that countries that trade under an agreement reveal higher bilateral flows than those that do not, as suggested by the shift of the density curve to the right. A causal interpretation should not be derived from the figure though, as higher bilateral trade volumes may well trigger intensified economic integration. A closer look reveals that the shape of the density function changes, such that I cannot expect the trade liberalization to have the same effect for all country-pairs along the distribution. This last observation will be central to the subsequent analysis.

Figure 2: Kernel densities, Glick and Rose data



Note: Average trade volumes in logs, 1997

In the following section, I describe the empirical results from the quantile and dynamic panel regressions. These will indicate a high level of heterogeneity across the trade volume and per-capita income distributions.

5 Results

In this section, I build my empirical analysis on the argumentation outlined in section three: I show that the gravity model can be adjusted to the dynamics that are persistent in the data on bilateral trade and that a differentiation of the

[29]The plots only show the trade volume distribution (on logs) without having controlled for any of the gravity variables. This should be kept in mind when interpreting the graphs.

dataset according to exogenous characteristics reveals a high level of heterogeneity with respect to a change in bilateral trade costs. Following the theoretical considerations on productivity differences and export networks, I analyze the potential heterogeneity along the per-capita income distributions. I incorporate the dynamic structure as well as panel specific estimation methods (fixed effects) in the regressions to control for unobservable time-invariant factors. In a first step, I benchmark the gravity model using Poisson estimates (including all observations) in order to properly compare them to the quantile regression.

5.1 Heterogeneity across the trade volume

The gravity model is first estimated with a Poisson regression due to the stated advantages over alternate regression methods in the previous section (Santos Silva & Tenreyro (2006)). The results are listed in Table 1 in the first column.

Table 1: Quantile regression, benchmark results, Glick and Rose data

Trade	Poisson	Q 0.1	Q 0.25	Q 0.50	Q 0.75	Q 0.90
Distance	-0.882***	-1.398***	-1.232***	-1.046***	-0.922***	-0.860***
	(0.220)	(0.013)	(0.008)	(0.007)	(0.006)	(0.008)
Border	0.084	-0.527***	-0.327***	-0.168***	-0.103***	-0.170***
	(0.128)	(0.062)	(0.039)	(0.029)	(0.027)	(0.034)
Language	0.916***	0.492***	0.517***	0.595***	0.682***	0.789***
	(0.043)	(0.024)	(0.015)	(0.011)	(0.010)	(0.013)
GDP AB	0.963***	1.103***	1.022***	0.926***	0.845***	0.776***
	(0.000)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
RTA	0.468***	2.130***	1.785***	1.580***	1.431***	0.840***
	(0.000)	(0.091)	(0.057)	(0.043)	(0.040)	(0.049)
constant	-25.571***	-31.06***	-27.92***	-23.47***	-19.73***	-16.40***
	(0.187)	(0.619)	(0.395)	(0.303)	(0.284)	(0.344)
N	219,558	219,558	219,558	219,558	219,558	219,558

Notes: * p<.1, ** p<.05, *** p<.01
Controlled for year effects.

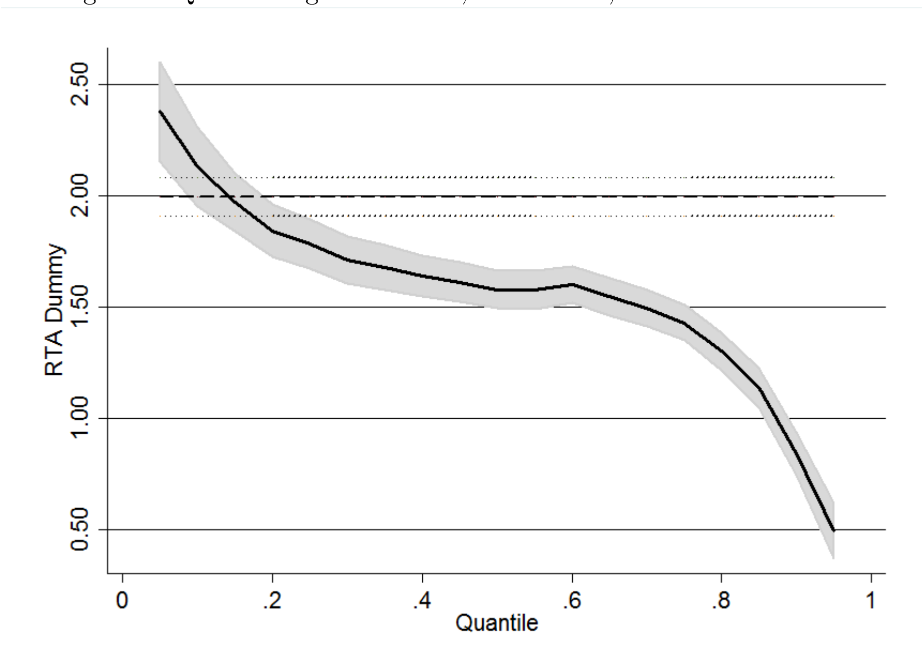
The Poisson estimate nicely reflects the expected results: The standard gravity variables such as distance, border, language and GDPs all wear the expected signs. The countries' GDPs have an effect of an additional 96.3% of bilateral trade, reflecting the responsiveness of the trade volume to changes in the product of the country-pair's GDPs. The estimates further reveal a singnificantly positive influence of a common regional trade agreement of about 59.7%.[30] A

[30]Calculated as $e^{0.468} = 1.597$.

comparison of this result to others in the literature has to be dealt with hindsight as the country coverages and thus the data may differ considerably. Nevertheless, a positive and significant relationship is consistent with previous findings.

The next columns plot the results for the quantile regression estimates. Special focus lies on the estimates for the RTA variable. The coefficients of this variable along the trade volume distribution are further displayed in figure 3. It reflects the behavior of the coefficient along the trade volume distribution, as well as the OSL estimates and the respective confidence intervals. The coefficients reveal a high level of significance throughout all quantile estimates, with the exception of the upper quantile (Q 0.90) which is negative. Other gravity variables such as the countries' GDPs and distance mirror a fading magnitude in their effect on the bilateral trade volume but remain significant at the 1%-level throughout all quantiles. The magnitude of the quantile estimates differs for the distance variable from lower (Q 0.25) to upper (Q 0.75) percentile by more than 100% when doubling the bilateral (great-circle) distance. As we can see from figure 3, the upper quantiles of the distribution reveal a lower magnitude in the effect on bilateral trade of the RTA variable. As a first robustness check, I have plotted a second quantile regression graph that is based on the self-compiled dataset. As we can see, the qualitative message remains valid in this case. RTAs have a higher elasticity for trading partners at the lower end of the trade volume distribution.

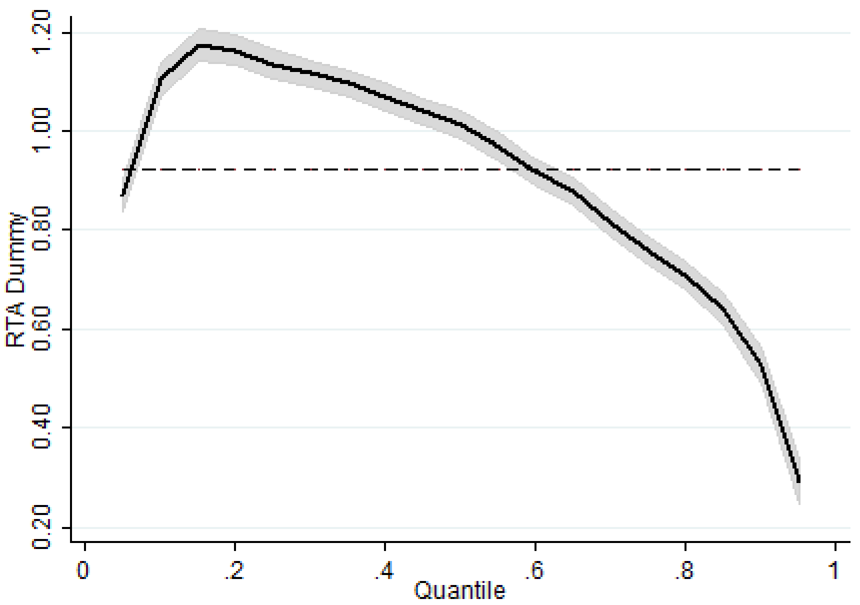
Figure 3: Quantile regression RTA, Benchmark, Glick and Rose data



Note: Explanatory variables according to table 1 and year-fixed effects included, but not displayed.

Most interestingly, distance and RTA refer to variable trade costs. These costs seem to have a fading effect the higher the bilateral trade volume is. As

Figure 4: Quantile regression RTA, Benchmark, own dataset



Note: Year-fixed effects included, but not displayed.

was mentioned in section three, the economic reasoning behind this observation may be derived from unobservable country-pair characteristics, such as intense trading relations that may be based on a trading network which alters the responsiveness to a change in trade costs. In order to control for such determinants, I introduce dynamics in the following step. The panel dataset allows us to make use of lagged values of the dependent variable, to check whether time-variant unobservables have any explanatory power in my specification or bias the coefficients of standard gravity variables.

Dynamics

An estimation including dynamics has been proposed by Bun & Klaassen (2002) due to severe first-order autocorrelation in their dataset. A closer look at the data used in this paper leads to a similar judgment: a test on first-order serial correlation in the data strongly rejects the hypothesis of no autocorrelation and hence points towards including variables that control for the dynamics in the data.[31]

Therefore, I start with the inclusion of the lagged value $(t-1)$ of the dependent variable (bilateral trade between i and j) to incorporate potential dependencies of the current trade flow on the past. The pairwise correlation between the two variables for the dataset amounts to 0.95. This high correlation reveals an almost perfect linear relationship between the past and current trade volume.

The inclusion of dynamics into the gravity model can be modeled via the Arellano & Bond (1991) or the Blundell & Bond (1998) estimators. Both in-

[31] I make use of a test for autocorrelation based on (Wooldridge 2002, 282-283).

corporate the lagged trade value on their respective right hand side. Computational complexity is introduced in the specification as the lagged trade X_{ijt} value is correlated with the error term in period t by definition. Furthermore, this dynamic panel bias is weakened for panels with a "large" time-dimension.[32] Therefore, I take another approach in order to combine the computational advantages of panel data with a closer look a distributional heterogeneity in the dataset. As mentioned in the previous chapter, I separate the dataset in four quarters according to their rank in the per-capita income distribution. Comparisons with the quantile regression approach should be drawn with caution, as quantile regressions include all observations for estimation by making use of the "check"-function that gives smaller weights to observations "further away" in the distribution. Further, the sub-sampling of the data according to an exogenous variable is not subject to the sample-selection bias (Heckman (1979)). In the next section, I perform Poisson panel regressions with fixed effects and include the lagged value of the dependent variable to control for the stated dynamics in the model.

5.2 Heterogeneity across the per-capita income

In the following, I separate the data according to an exogenous variable in the gravity estimates: the per-capita income level. I am interested in whether the potential trade-creating effect of a trade agreement differs for less developed economies compared to more developed ones (measured as combined per-capita income). In particular, I want to investigate whether the dynamics (that played a significant role in previous estimates) are also responsible for a large part of the heterogeneity in the per-capita context. The sub-sampling of the data is performed as illustrated in figure 1 in section four which plots the respective "sub-distributions" of the four quantiles. I expect the per-capita income to be exogenous in the outcome equation in order to conform to exogenous sample selection. The results of the regression are described in table 2.

We can see that the lower income country-pairs are more strongly affected by a common trade initiative whereas the effect weakens along the income distribution. This is an interesting finding because is suggests that less developed economies (and what they trade among each other) benefit to a larger extend from a trade agreement. As expected, the inclusion of the dynamics in the gravity model weakens the overall effect of the variable of interest along the per-capita income distribution. Nevertheless, the "fading" effect is not completely absorbed by the lagged trade volume.

Table 3 plots the respective results for the second dataset that is based on a longer time period, relies on exports as the dependent variable and includes more RTAs. Again, the qualitative results remain valid: higher per-capita income country-pairs are associated with a lower elasticity with respect to RTAs. Even though the magnitude differs, compared to the dataset by Glick & Rose (2002), the message remains. One thing that cannot be drawn from my own dataset is a increasing elasticity of the trade volume with respect to the lagged trade flow for higher per-capita incomes. Nevertheless, this should not distract from the qualitatively comparable and robust result.

[32]See Alvarez & Arellano (2003) for an analysis of the asymptotic properties of panel estimators.

Table 2: Regression by quantiles of per-capita income, Poisson fixed effects, Glick and Rose data

Trade	Q 1	Q 2	Q 3	Q 4
No Lag				
RTA	1.948***	0.775***	0.972***	0.405***
	(0.401)	(0.253)	(0.366)	(0.083)
N	54,019	54,169	54,409	54,518
incl. Lag				
LagTrade	0.604***	0.602***	0.722***	0.849***
	(0.009)	(0.015)	(0.014)	(0.008)
RTA	0.660***	0.333***	0.369***	0.0858***
	(0.18)	(0.045)	(0.128)	(0.012)
N	44,875	48,668	50,992	52,834

Notes: * p<.1, ** p<.05, *** p<.01
Controlled for year effects and explanatory variables according to table 1. Standard errors have been bootstrapped.

In combination with the results of Chaney (2008) and Rodrik (2006) on the trade structure, the level of economic development and the sensitivity with respect to a change in variable trade costs, we can assert that less developed economies are more active in trade with homogeneous goods. The trade-creating effect observed in tables 2 and 3 has to be interpreted against this background, namely that the predominant trade initiatives may be more effective for trade with homogeneous goods. The magnitude of the trade creation by a liberalization measure should then be mirrored by a respective analysis on the composition of the trade basket along the per-capita income distribution. The results give rise to a structural differentiation of trade initiatives in combination with the needed theoretical underpinnings coming from models that incorporate productivity differences and hence derive different export structures for different levels of economic development.

The results may also be interpreted against the background of a higher sensitivity to trade barriers in vertical production networks (see Yi (2003)). Countries with lower per-capita income levels are often involved in production networks that lead to more intense cross-border trade due to the multiple production processes. The evolution of the trading relations of the East Asian economies is an example for this case (Moelders & Volz (forthcoming)).

The results in tables 2 and 3 further confirm the estimates of Helpman et al. (2008) who also differentiate their dataset according to the income-per capita levels, but focus on the heterogeneity with respect a change in bilateral distances. They classify the country-pairs into three sub-categories: trade among South-South, trade among North-South and trade among North-North countries. Even though the authors do not rely on a dynamic structure, the differences in the estimates are quite similar.

Tables 2 and 3 also display the coefficients of the RTA variable without the lagged trade flow. The results show that lower per-capita income trading part-

Table 3: Regression by quantiles of per-capita income, Poisson fixed effects, own dataset

Trade	Q 1	Q 2	Q 3	Q 4
No Lag				
RTA	0.849***	0.345***	0.079***	0.130***
	(0.001)	(0.001)	(0.001)	(0.002)
N	69,426	68,331	66,574	56,620
incl. Lag				
LagTrade	0.762***	0.729***	0.748***	0.655***
	(0.001)	(0.001)	(0.001)	(0.001)
RTA	0.201***	0.111***	0.017***	0.047***
	(0.001)	(0.001)	(0.001)	(0.002)
N	61,805	61,780	59,640	50,038

Notes: * p<.1, ** p<.05, *** p<.01
Controlled for year effects, GDPs and Population.

ners exhibit a higher elasticity with respect to trade agreements even without a lag in the regression equation. Inclusion of dynamics nevertheless significantly reduces the magnitude of the effect and points towards a somewhat stronger effect of trade persistence for trading partners with a higher level of economic development.

6 Conclusion

Trade persistence is observed for trading partners along all levels of economic development and trade volume. This paper claims that the driver of this persistence are investments in the trading relationship between country-pairs. This hypothesis has been evaluated against a theory of market penetration costs that allows heterogeneity in access to the market along the productivity distribution. Particular focus is put on the persistence in the network structure that may reflect the unobservable persistence in bilateral trade flows. This conclusion is then used to examine a potential heterogeneity at the country-level.

I make use of a large panel dataset to uncover potential heterogeneity in traditional gravity-model estimates, in particular for the variable denoting the trade-creating effect of RTAs. The inclusion of dynamics has proven to be important in the econometric approach, as bilateral trade flows reflect a high level of persistence over time. If controlled for the time-dependency, I confirm what has previously been stated in the literature: an overestimation of the trade-creating effects of trade agreements. Additionally, I find that the overestimation effect is increasing from lower to upper quantiles of the trade distribution as the state dependence is more prominent for higher per-capita income trading partners (**H 1**). Moreover, I investigate the presence of heterogeneity along the per-capita income levels. Trade initiatives reveal stronger trade effects for trading partners at the lower end of the income distribution (**H 2**). While trade agreements are a powerful tool for trading partners along all levels of economic development, stronger effects are observed for those at the lower end of the per-capita income distribution.

References

Alvarez, J. & Arellano, M. (2003), 'The Time Series and Cross-Section Asymptotics of Dynamic Panel Data Estimators', *Econometrica* **71**(4), 1121–1159.

Anderson, J. (1979), 'A Theoretical Foundation for the Gravity Equation', *American Economic Review* **69**(1), 106–116.

Anderson, J. & Wincoop, E. v. (2003), 'Gravity with Gravitas: A Solution to the Border Puzzle', *American Economic Review* **93**(1), 170–192.

Angrist, J. & Pischke, J.-S. (2008), *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton University Press.

Arellano, M. & Bond, S. (1991), 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations', *The Review of Economic Studies* **58**(2), 277–297.

Arkolakis, C. (2009), A Unified Theory of Firm Selection and Growth. Yale University, New Haven. Mimeo.

Arkolakis, C. (2010), 'Market Penetration Costs and the New Consumers Margin in International Trade', *The Journal of Political Economy* **118**(6), 1151–1199.

Baier, S. & Bergstrand, J. (2002), On the Endogeneity of International Trade Flows and Free Trade Agreements. Mimeo.

Baier, S. & Bergstrand, J. (2007), 'Do free trade agreements actually increase members' international trade?', *Journal of International Economics* **71**(1), 72–95.

Baier, S. & Bergstrand, J. (2009), 'Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation', *Journal of International Economics* **77**(1), 77–85.

Baltagi, B. (2005), *Econometric Analysis of Panel Data*, Wiley Publishing.

Benedictis, L. D. & Vicarelli, C. (2005), 'Trade Potentials in Gravity Panel Data Models', *The B.E. Journal of Economic Analysis & Policy* **5**(1).

Bergstrand, J. (1985), 'The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence', *Review of Economics and Statistics* **67**(3), 474–481.

Blundell, R. & Bond, S. (1998), 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics* **87**(1), 115–143.

Bun, M. J. & Klaassen, F. J. (2002), The Importance of Dynamics in Panel Gravity Models of Trade. Mimeo.

Campbell, D. L. (2010), History, culture, and trade: a dynamic gravity approach. MPRA Working Paper 24014.

Chaney, T. (2008), 'Distorted Gravity: The Intensive and Extensive Margins of International Trade', *American Economic Review* **98**(4), 1707–1721.

Chang, P.-L. & Lee, M.-J. (forthcoming), 'The WTO Trade Effect', *Journal of International Economics* .

Combes, P., Lafourcade, M. & Mayer, T. (2005), 'The trade-creating effects of business and social networks: evidence from France', *Journal of International Economics* **66**(1), 1–29.

Dufrenot, G., Mignon, V. & Tsangarides, C. (2010), 'The trade-growth nexus in the developing countries: a quantile regression approach', *Review of World Economics* **146**(4), 731–761.

Eaton, D. (2009), Trade and Intellectual Property Rights in the Agricultural Seed Sector. Mimeo. LEI, Wageningen University & Research Centre, The Netherlands.

Eichengreen, B. & Irwin, D. A. (1998), The Role of History in Bilateral Trade Flows, *in* J. Frankel, ed., 'The Regionalization of the World Economy', University of Chicago Press, pp. 33 – 62.

Eicher, T. S. & Henn, C. (2011), 'In search of WTO trade effects: Preferential trade agreements promote trade strongly, but unevenly', *Journal of International Economics* **83**(2), 137–153.

Glick, R. & Rose, A. (2002), 'Does a currency union affect trade? The time-series evidence', *European Economic Review* **46**(6), 1125–1151.

Harris, M. N., Kónya, L. & Mátyás, L. (2009), Some Empirical Facts About International Trade Flows. Mimeo.

Head, K., Mayer, T. & Ries, J. (2010), 'The erosion of colonial trade linkages after independence', *Journal of International Economics* **81**(1), 1–14.

Heckman, J. J. (1979), 'Sample Selection Bias as a Specification Error', *Econometrica* **47**(1), 153–161.

Helpman, E., Melitz, M. & Rubinstein, Y. (2008), 'Estimating Trade Flows: Trading Partners and Trading Volumes', *The Quarterly Journal of Economics* **123**(2), 441–487.

Koenker, R. & Bassett, G. (1978), 'Regression Quantiles', *Econometrica* **46**(1), 33–50.

Koenker, R. & Hallock, K. F. (2001), 'Quantile Regression', *Journal of Economic Perspectives* **15**(4), 143–156.

Magee, C. (2008), 'New measures of trade creation and trade diversion', *Journal of International Economics* **75**(2).

Melitz, M. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity', *Econometrica* **71**(6), 1695–1725.

Milgram, J. & Moro, A. I. (2010), 'The asymmetric effect of endowments on vertical intra-industrial trade', *World Economy* **33**(5), 746–777.

Moelders, F. & Volz, U. (forthcoming), 'Trade creation and the status of FTAs: empirical evidence from East Asia', *Review of World Economics* .

Nardis, S. & Vicarelli, C. (2003), 'Currency unions and trade: The special case of EMU', *Review of World Economics* **139**(4), 625–649.

Nguyen, T. & Arcand, J.-L. (2009), Gravity Equation for Different Product Groups: A study at product level. DEPOCEN Working Paper.

Nickell, S. (1981), 'Biases in Dynamic Models with Fixed Effects', *Econometrica* **49**(6), 1417–1426.

Powers, W. M. (2007), Endogenous Liberalization and Sectoral Trade Endogenous liberalization and sectoral trade. Office of Economics Working Paper 2007-06-B, U.S. International Trade Commission.

Rodrik, D. (2006), 'What's So Special about China's Exports?', *China & World Economy* **14**(5).

Rose, A. K. (2004), 'Do We Really Know That the WTO Increases Trade?', *American Economic Review* **94**(1).

Santos Silva, J. M. C. & Tenreyro, S. (2006), 'The Log of Gravity', *The Review of Economics and Statistics* **88**(4).

Schiff, M. (1996), Small is Beautiful: Preferential Trade Agreements and The Impact of Country Size, Market Share, Efficiency and Trade Policy. Policy Research Working Paper 1668.

Subramanian, A. & Wei, S.-J. (2007), 'The WTO promotes trade, strongly but unevenly', *Journal of International Economics* **72**(1).

Tinbergen, J. (1962), *Shaping the World Economy: Suggestions for an International Economic Policy*, Twentieth Century Fund, New York.

Winkelmann, R. (2008), *Econometric analysis of count data*, Springer.

Wonnacott, P. & Lutz, M. (1989), Is there a Case for Free Trade Areas?, *in* J. Schott, ed., 'Free Trade Areas and U.S. Trade Policy', Institute for International Economics, Washington D.C.

Wooldridge, J. (2002), *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

Wooldridge, J. (2009), *Introductory Econometrics: A Modern Approach*, South-Western College.

Yi, K.-M. (2003), 'Can Vertical Specialization Explain the Growth of World Trade?', *Journal of Political Economy* **111**(1).